

Insufficienza Cardiaca Acuta e Avanzata

Il timing per la Cardiochirurgia

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STOCK SHOT



- 1) Sistemi dinamici
- 2) Traiettorie
- 3) Cibernetica di I e II ordine



Pz 37aa, FE 19%,
SCAI B, DTD 56 mm,
disf diast III, PAPs 55
mmHg, IM lieve-
moderata, inotropi
all'esordio

Pz 40aa, FE 30%, DTD 62mm,
disf diast I gr, PAPs 35mmHg,
IM lieve-moderata,
No ospedalizzazioni da 3 anni.
Biso 2.5 mg, S/V 49/51 mg,
Epler 25 mg, dapa 10mg

Pz 37aa, familiarità
per SD, NYHA I, FE
55%, DTD 52 mm,
diastole normale,
PAPs 25 mmHg, IM
lieve



Remember acronym to assist in decision making for referral to advanced heart failure specialist:

I-NEED-HELP (also see *Table 6*)

I: Intravenous inotropes

N: NYHA IIIB/IV or persistently elevated natriuretic peptides

E: End-organ dysfunction

E: Ejection fraction $\leq 35\%$

D: Defibrillator shocks

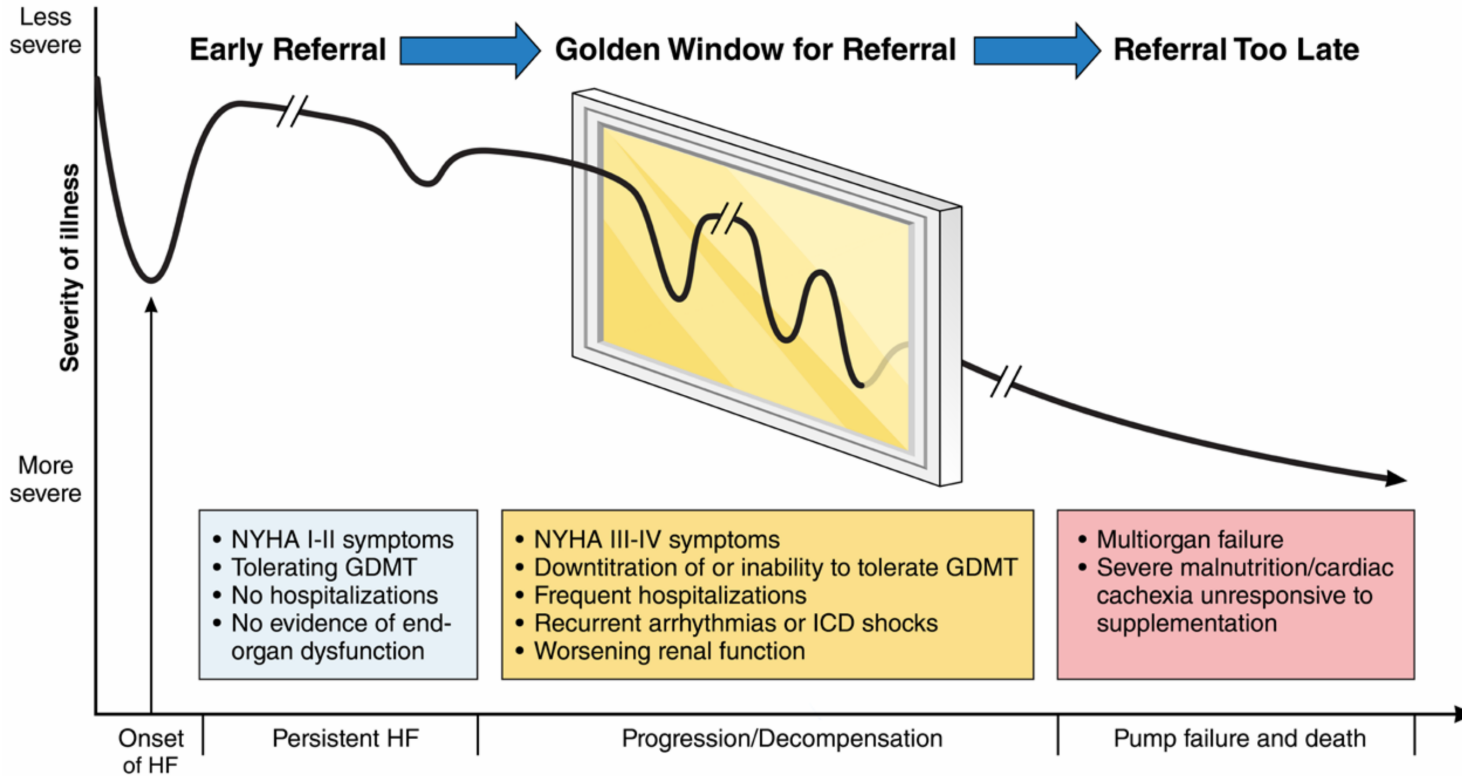
H: Hospitalizations > 1

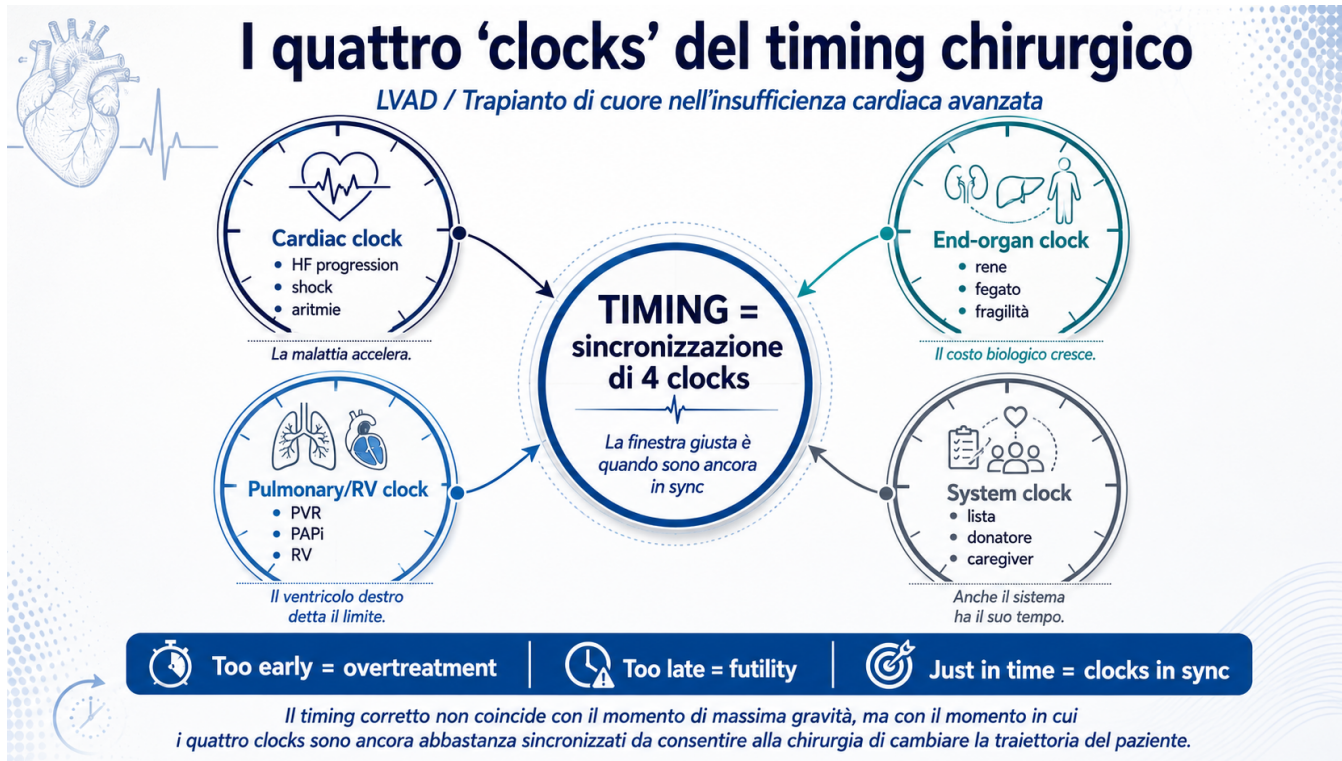
E: Edema despite escalating diuretic agents

L: Low blood pressure, high heart rate

P: Prognostic medication – progressive intolerance or down-titration of GDMT

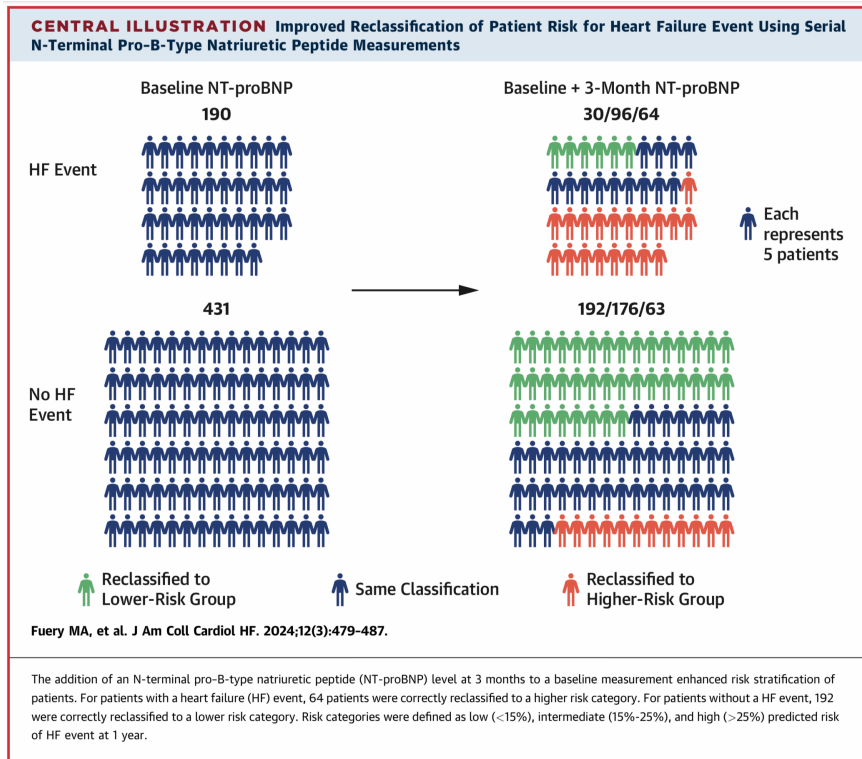






La Valutazione della Traiettoria

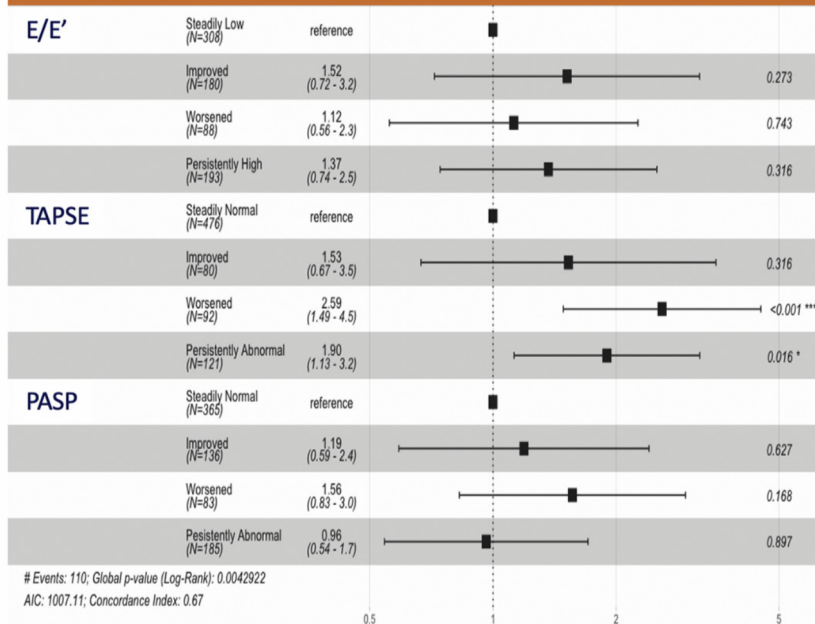




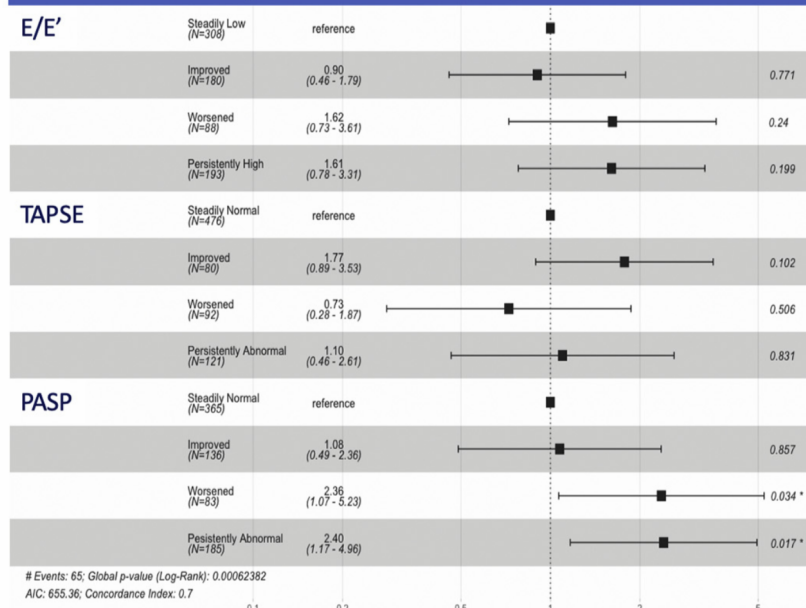
Fuery, M et al.
Prognostic Impact of Repeated NT-proBNP
Measurements in Patients With Heart Failure
With Reduced Ejection Fraction.
J Am Coll Cardiol HF. 2024 Mar, 12 (3) 479–487



HRs in Persistently Restrictive/Worsened to Restrictive FP



HRs in Steadily Non-Restrictive/Improved to Non-RFP

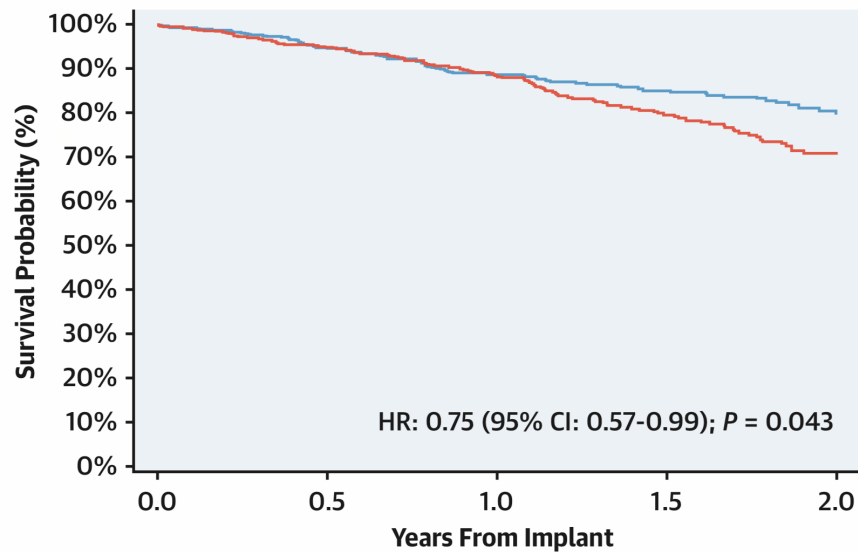


Ghio S et al Prognostic relevance of Doppler echocardiographic re-assessment in HFrEF patients.

Int J Cardiol. 2021 Mar 15;327:111-116.



FIGURE 4 Survival for Implantable Hemodynamic Monitoring and Medical Therapy in Pooled Population



No. At Risk					
Treatment	666	539	345	237	158
Control	684	556	355	213	115

— Treatment — Control

Lindenfeld J et al Haemodynamic-guided management of heart failure (GUIDE-HF): a randomised controlled trial.
Lancet. 2021 Sep 11;398(10304):991-1001



Domain	Key Study	Single vs. Serial Finding	Effect Size	References
NT-proBNP	Fuery et al. (GUIDE-IT), 2024	Serial HR 1.66 vs. baseline HR 1.17 per doubling	42% stronger association with serial	JACC
NT-proBNP burden	Dong et al. (GUIDE-IT), 2024	Cumulative time above threshold predicts outcomes	HR 13.15 for severe burden vs. none	American Journ...
NT-proBNP response	Januzzi et al. (GUIDE-IT), 2019	Trajectory direction (rising vs. falling) determines prognosis regardless of baseline	HR 0.26 for responders	JACC
LVEF trajectory	Lupón et al., 2018	Declining LVEF in preceding period predicts mortality	Independent of absolute LVEF	JACC
LVEF change	BEST trial (Bristow et al.)	5% LVEF change = most significant dynamic predictor	Strongest single dynamic variable	JACC
Echo reassessment	Ghio et al., 2021	Re-assessment model C-index 0.74 vs. baseline 0.69	Additive to BNP and NYHA changes	JACC
6MWT trajectory	Atlas et al., 2025	Joint model AUC +0.116 over single measurement	HR 0.86 per 10 m/yr slope improvement	JACC
PA pressure monitoring	CHAMPION trial	Continuous monitoring reduces HF hospitalizations 28-37%	Mortality reduction 57% on optimal GDMT	International Jo...
eGFR trajectory	Kobayashi et al., 2025	Steeper eGFR decline (-4.83 vs. -1.18/yr) precedes events by 1 year	Slope > cutoff for early detection	American Journ...
Renal biomarker slopes	Brankovic et al. (Bio-SHIFT), 2018	Slopes strongest predictors of LVAD/transplant/death	Creatinine slope HR 1.57; KIM-1 slope HR 1.64	JACC
Frailty trajectory	Kaufmann et al., 2025	Improving frailty HR 0.65; worsening frailty	Direction of change > baseline status	JACC



La cibernetica è lo studio di come i sistemi si regolano, comunicano, si correggono e mantengono un comportamento orientato ad uno scopo attraverso meccanismi di feedback

Nella cibernetica di I ordine (N. Wiener)
l'osservatore studia il sistema dall'esterno

La cibernetica di II ordine (H. Von Foerster)
prevede invece che l'osservatore faccia parte del sistema ed interagisca con esso



Il pz con ADHF non è un oggetto statico da classificare ma un sistema dinamico da osservare nella sua evoluzione (traiettoria) e nelle sue risposte a: decongestione, carico volumico, inotropi, esercizio fisico, ecc (cibernetica di II ordine)

Von Foerster diceva: se vuoi conoscere, impara ad agire!



Primary CPET Variables

VE/Vco ₂ Slope	Peak Vo ₂	EOV	P _{ET} CO ₂
<u>Ventilatory Class I</u>	<u>Ventilatory Class A</u>	Not Present	Resting P _{ET} CO ₂ ≥33.0 mm Hg 3-8 mm Hg increase during ET
VE/Vco ₂ slope <30.0	Peak Vo ₂ >20.0 ml·kg ⁻¹ ·min ⁻¹		
<u>Ventilatory Class II</u>	<u>Ventilatory Class B</u>	Present	Resting P _{ET} CO ₂ <33.0 mm Hg <3 mm Hg increase during ET
VE/Vco ₂ slope 30.0-35.9	Peak Vo ₂ = 16.0-20.0 ml·kg ⁻¹ ·min ⁻¹		
<u>Ventilatory Class III</u>	<u>Ventilatory Class C</u>		
VE/Vco ₂ slope 36.0-44.9	Peak Vo ₂ = 10.0-15.9 ml·kg ⁻¹ ·min ⁻¹		
<u>Ventilatory Class IV</u>	<u>Ventilatory Class D</u>		
VE/Vco ₂ slope ≥45.0	Peak <10.0 ml·kg ⁻¹ ·min ⁻¹		

Standard ET Variables

Hemodynamics	ECG	HRR
Rise in systolic BP during ET	No sustained arrhythmias, ectopic foci, and/or ST-segment changes during ET and/or in recovery	>12 beats at 1 min recording
Flat systolic BP response during ET	Altered rhythm, ectopic foci, and/or ST-segment changes during ET and/or in recovery: did not lead to test termination	≤12 beats at 1 min recording
Drop in systolic BP during ET	Altered rhythm, ectopic foci, and/or ST-segment changes during ET and/or in recovery: led to test termination	

Patient Reason for Test Termination

Lower extremity muscle fatigue	Angina	Dyspnea
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Interpretation

Il ruolo del CPET

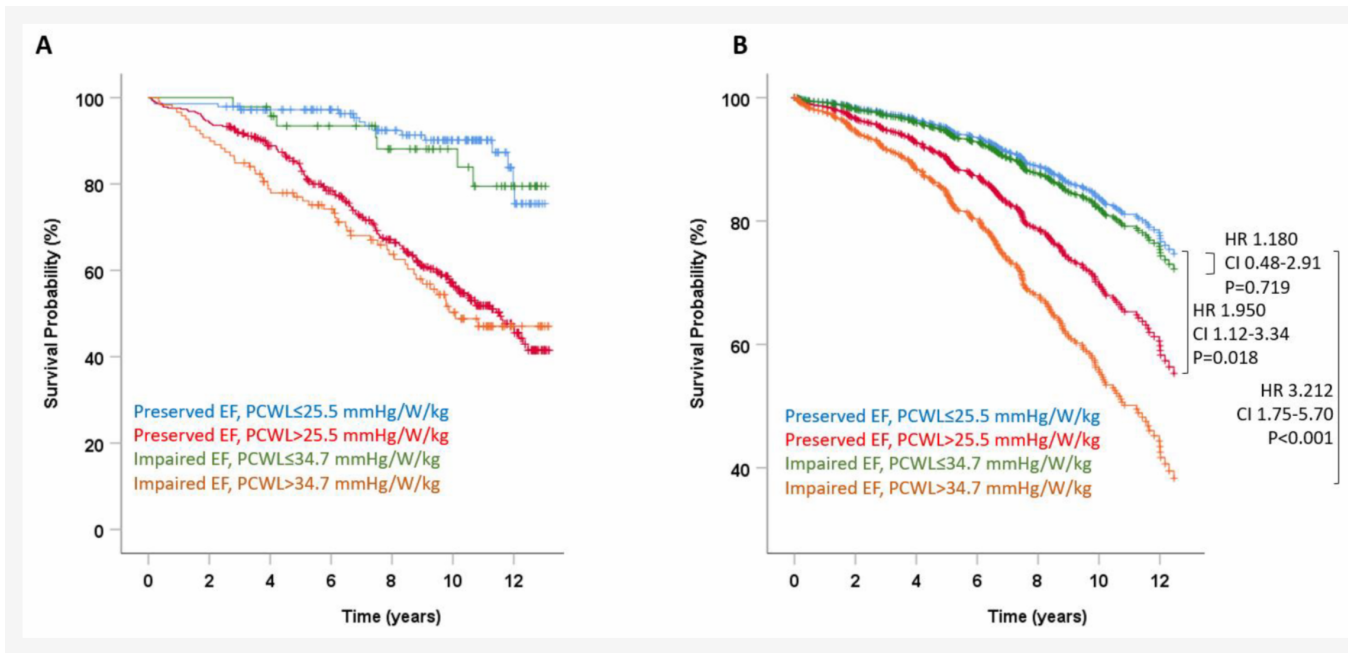
Guazzi M et al J Am Coll Cardiol
2017;70: 1618-36



Exercise Capacity: Frequency of Assessment

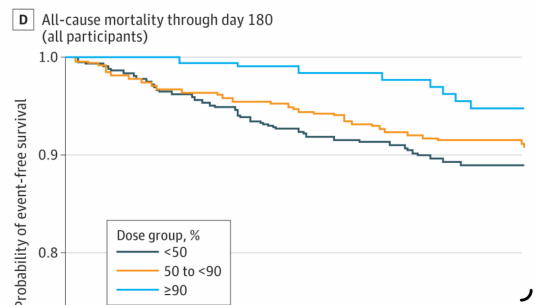
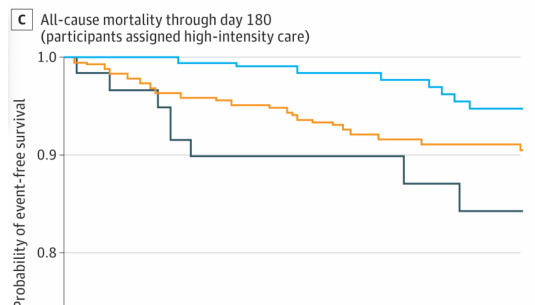
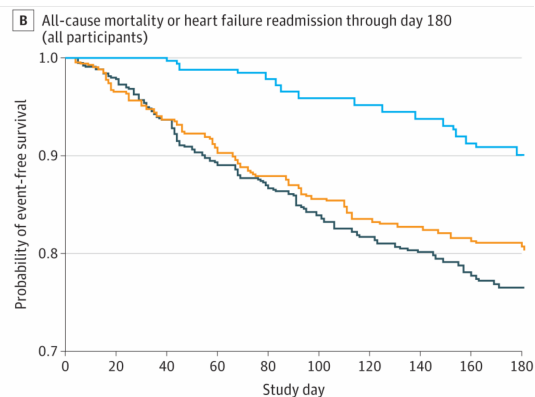
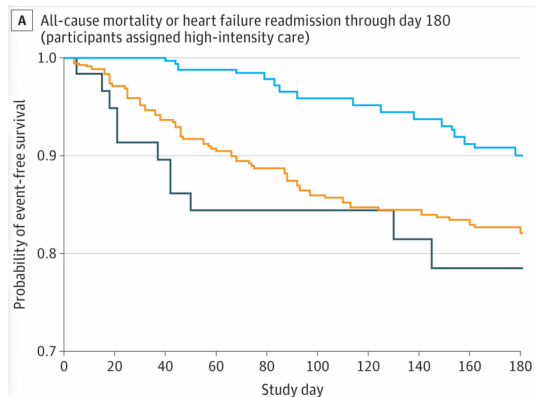
Recommendations for Repeat Testing on the Waitlist: Exercise Capacity: Frequency of Assessment		
COR	LOE	RECOMMENDATIONS
2b	C-EO	1. Serial CPET testing after initial listing for HT may be considered in patients with change in clinical status or in patients who remain on a waitlist for >1 year.
3: No Benefit	C-EO	2. Changing patient listing status solely on the criterion of a peak VO ₂ measurement should not be done.





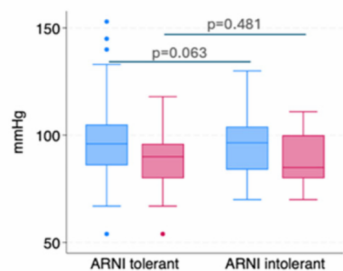
Ahlgrim, C. et al *J. Clin. Med.* **2022**, 11, 5901



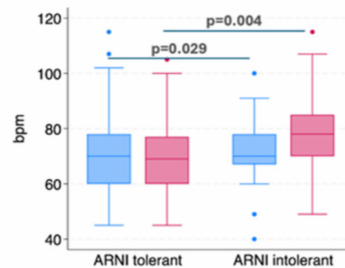


Cotter G et al. JAMA Cardiol. 2024;9(2):114–124.

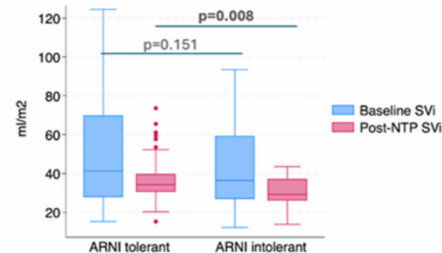




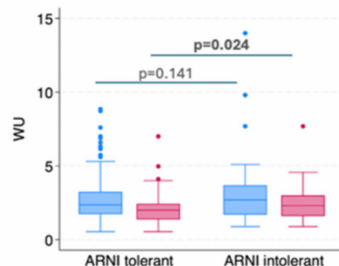
Systolic Arterial Pressure



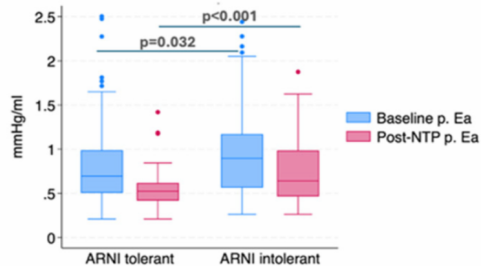
Heart Rate



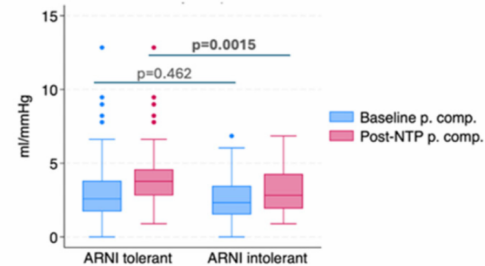
Stroke Volume Index



Pulmonary Vascular Resistance



Pulmonary Elastance



Pulmonary compliance



Perturbation Type	What It Reveals (vs. Static Observation)	Key Evidence	References
Exercise (CPET)	Circulatory reserve, chronotropic competence, ventilatory efficiency	Peak VO_2 and VE/VCO_2 slope: Class I recommendation; LVEF alone "misguides decision-making"	 JACC +1
Exercise NT-proBNP	Dynamic neurohormonal response to stress	Only exercise-provoked NT-proBNP retained in multivariate model; resting values dropped out	Peptides +1
Exercise hemodynamics (RHC)	Cardiac output reserve, pressure-flow relationships	ΔCO independently predicted transplant/LVAD-free survival; resting hemodynamics did not	American Journ... +1
GDMT rapid titration	Neurohormonal responsiveness, reverse remodeling capacity	STRONG-HF: 34% relative risk reduction; nonresponders identified by NT-proBNP trajectory	Clinical Medicine +1
Inotrope wean	Cardiac dependence on exogenous support	UNOS Status 3 extension requires demonstrated wean failure (CI, creatinine, lactate, SvO_2)	 Lancet
Diuretic challenge	Natriuretic efficiency, intrarenal hemodynamics	Positive sodium balance despite fluid loss predicts worse survival (ROSE-AHF)	 JACC +1
Vasodilator challenge	Pulmonary vascular reversibility	Class I for transplant candidacy; $\text{PVR} < 2.5 \text{ WU}$ with vasodilator = excellent surgical outcomes	 Lancet +1
LVAD speed reduction	Native myocardial recovery potential	RESTAGE-HF: 50% explantation rate with perturbation-response protocol vs. ~3% in routine care	 JACC +1



Per concludere...

Nell'insufficienza cardiaca avanzata, l'osservatore di primo ordine descrive lo stato attuale del sistema.

L'osservatore di secondo ordine, invece, interviene, titola la terapia medica, valuta la risposta, sottopone il paziente a esercizio, prova a sospendere gli inotropi e scarica il ventricolo. Così facendo, accede alle dinamiche nascoste del sistema, alla sua capacità di recupero e alla sua reale traiettoria.

Questa è la base concettuale di ciò che von Foerster avrebbe definito il passaggio dai "sistemi osservati" all' "osservazione dell'osservazione" ed è proprio questo passaggio che consente di orientare in modo più affidabile la decisione verso trapianto, LVAD o prosecuzione della terapia medica!



Per chi non può
proprio fare a meno...

Therapy	Clinical Scenario	ACC/AHA/H... (2022)	ESC (2021)	INTERMACS Profile
Heart Transplantation	Selected patients with Stage D / advanced HF refractory to GDMT	COR 1 , LOE: C-LD	COR 1 , LOE: C	Profiles 1-4 (most common)
Durable LVAD	NYHA IV, inotrope-dependent or on temporary MCS	COR 1 , LOE: A	COR 2a , LOE: A	Profiles 1-3 (87.6% of recipients)
Durable LVAD	NYHA IV despite GDMT, not yet inotrope-dependent	COR 2a , LOE: B-R	COR 2a , LOE: B	Profiles 3-4
LVAD as BTT	Transplant-eligible, hemodynamic stabilization needed	Not separately specified	COR 2a , LOE: C	Profiles 1-3
LVAD as DT	Transplant- ineligible , end-stage HF	Not separately specified	COR 2a , LOE: B	Profiles 2-4
Temporary MCS	Cardiogenic shock — bridge to decision/recovery	COR 2a , LOE: B-NR	COR 2a , LOE: C	Profile 1
IV Inotropes (bridge)	Awaiting MCS or transplant	COR 2a , LOE: B-NR	COR 2a , LOE: C	Profiles 1-3
IV Inotropes (palliative)	Ineligible for MCS or transplant	COR 2b , LOE: B-NR	— (no recommendation)	Profiles 4-7
Long-term inotropes (non-bridge, non-palliative)	Chronic use without advanced therapy plan	COR 3 (Harm) , LOE: B-R	— (no recommendation)	—



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GRAZIE

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Trapianto cardiaco		LVAD	
Controindicazioni assolute	Controindicazioni relative	Controindicazioni relative	Controindicazioni assolute
• Patologia sistemica con aspettativa di vita < 2 anni • Ipertensione polmonare fissa/non reversibile	• Età > 72 anni • Infezione attiva, eccetto infezioni correlate a device/VAD • Diabete severo con danno d'organo • Grave vasculopatia periferica o cerebrovascolare • Ulcera peptica attiva • Obesità patologica o cachessia • Creatinina > 2,5 mg/dL o clearance creatinina < 25 mL/min • FEV1 < 40% del predetto • Ipertensione arteriosa difficile da controllare • Patologia neurologica o neuromuscolare irreversibile • Disturbo psichiatrico attivo o instabilità psicosociale • Scarsa aderenza terapeutica • Uso di droghe, tabacco o alcol negli ultimi 6 mesi • Disfunzione epatica: bilirubina totale > 2,5 mg/dL, transaminasi > 3x norma e/o INR > 1,5 fuori terapia con warfarin • Trombocitopenia indotta da eparina	• Età > 80 anni • Obesità patologica o cachessia • Patologia muscoloscheletrica che compromette la riabilitazione • Infezione sistemica attiva o intubazione prolungata • Neoplasia non trattata • Grave vasculopatia periferica o cerebrovascolare • Uso di droghe, tabacco o alcol negli ultimi 6 mesi • Deficit cognitivo significativo • Instabilità psicosociale	• Epatopatia irreversibile • Nefropatia irreversibile • Patologia neurologica o neuromuscolare irreversibile • Scarsa aderenza terapeutica • Disturbo psichiatrico attivo o instabilità psicosociale

